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Prompt Engineering for Critical Thinking and Equity in General Education

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ABSTRACT

This paper introduces prompt engineering using large language models (LLMs), such as ChatGPT, as a groundbreaking method for enhancing critical thinking and promoting equity in education. Critical thinking is crucial to student success in today's rapidly evolving, information-rich world. By training students to write effective prompts for AI systems, this paper engages learners in inquiry, hypothesis testing, and iterative problem-solving, fostering essential critical thinking skills. Furthermore, prompt engineering democratizes education by providing underprivileged students with free or low-cost access to advanced AI tools, helping bridge educational disparities.

Integrating prompt engineering into general education promotes both cognitive development and social equity. This approach addresses the challenge of embedding critical thinking skills into curricula while ensuring inclusivity. Prompt engineering, defined as the process of crafting AI prompts, leverages ChatGPT—a widely accessible and cost-effective tool that aligns with modern educational objectives. The cognitive processes involved mirror those of programming, encouraging active, reflective learning that significantly enhances students' critical thinking abilities. The availability and affordability of ChatGPT ensure that all students, regardless of socio-economic background, can access high-quality educational resources, thus leveling the playing field for diverse learners.

This paper, supported by a comprehensive literature review spanning cognitive psychology, educational psychology, instructional design, computer science education, and sociocultural theory, demonstrates strong evidence that programming and interactive learning environments improve cognitive skills, logical reasoning, and creativity. Incorporating AI-driven active learning strategies further enhances student engagement and educational outcomes.

This paper proposes prompt engineering as a key component of the general education curriculum. It outlines a transformative, inclusive educational model that combines theoretical lessons, hands-on activities, and discussions on ethical AI usage. This innovative approach equips students with the critical thinking skills required for success in a technology-driven world while ensuring equitable, high-quality learning opportunities for all.

KEYWORDS: *prompt engineering, critical thinking, equity and diversity, ChatGPT, general education, cognitive skills, AI in education, interactive learning, curriculum development, inclusive education.*

INTRODUCTION

Background

Critical thinking is a foundational pillar of higher education, serving as a key driver of students' analytical and evaluative abilities. Educational institutions worldwide have recognized the importance of embedding critical thinking into curricula to prepare students for the complexities of modern life. Smith and Kosslyn (2007) assert that "the ability to think critically is crucial for students to navigate the complexities of modern society" (p. 4). Equally, promoting equity and diversity has become a central focus in education, with institutions striving to create inclusive environments that foster the success of all students. Banks and Banks (1995) emphasize that "an inclusive educational environment is essential for the academic and social development of all students" (p. 102). However, despite these widespread efforts, embedding critical thinking alongside equity and diversity in general education remains a significant challenge.

The importance of critical thinking has only increased in today's rapidly evolving, information-dense world (Wing, 2006). Evaluating, interpreting, and generating information is essential for academic success and professional competence (Mayer, 2014). An innovative way to foster these skills is

through training students to write prompts for large language models (LLMs) like ChatGPT. The process of crafting effective prompts requires inquiry, hypothesis formation, testing, and iterative refinement, closely mirroring the methodologies used in scientific and logical reasoning (Bransford, Brown, & Cocking, 2000). Engaging in the practice of writing prompts for LLMs immerses students in cycles of critical thinking, prompting them to anticipate outcomes, analyze results, and continuously improve their approaches, thereby strengthening their analytical abilities.

Purpose

This paper proposes the integration of **"Prompt Engineering into General Education"** either as a standalone General Education (GE) course or integrated into broader GE curricula. The integration depends on the institution's educational goals, the depth of the subject matter, and its relevance across various fields. The proposal addresses two imperatives: enhancing critical thinking and fostering equity and diversity. **Prompt engineering**, defined as the process of designing and refining prompts to generate targeted responses from AI models like ChatGPT, offers a unique, reflective, and active learning experience. By leveraging the capabilities of ChatGPT, this course provides an affordable and widely accessible educational tool that aligns with contemporary pedagogical aims.

One of the greatest advantages of LLMs like ChatGPT is their accessibility—many are available either for free or at low cost—presenting an unprecedented opportunity to democratize education (Warschauer, 2004). This accessibility mainly benefits underprivileged students who might otherwise lack the resources to access high-quality learning tools. By integrating prompt engineering into the general curriculum, educational institutions can ensure that students from diverse socio-economic backgrounds have equal opportunities to develop critical thinking skills. This democratization of educational resources fosters a more equitable learning environment, enabling all students to thrive and compete on equal footing, thereby advancing inclusivity and diversity within academic communities (DiMaggio &Hargittai, 2001).

Significance

Integrating prompt engineering into general education is significant because it has the potential to democratize learning and cultivate critical thinking in an inclusive, accessible manner. As Selwyn (2011) notes, "the widespread availability of free or low-cost educational technologies can significantly level the playing field for students from diverse backgrounds" (p. 45). ChatGPT, as a free or low-cost AI-driven tool, offers an ideal solution for educational institutions with varying financial capacities to enhance critical thinking and equity.

Incorporating prompt engineering into curricula allows students to engage in interactive, hands-on learning while exploring diverse perspectives. This approach promotes critical thinking development and helps bridge educational gaps, creating a dynamic and equitable educational experience. Additionally, prompt engineering equips students with the cognitive and problem-solving skills necessary to succeed in today's technology-driven world, regardless of their socio-economic background. By ensuring that all students have equal access to cutting-edge learning tools, educational institutions can promote inclusivity and democratize education, fulfilling the broader mission of equity and diversity in academia.

LITERATURE REVIEW

Cognitive Psychology

Theoretical Framework on Cognitive Development and Critical Thinking

Cognitive development theories provide a robust foundation for understanding how individuals develop and enhance critical thinking skills. Piaget's stages of cognitive development and Vygotsky's sociocultural theory both emphasize interaction and guided learning as essential components of cognitive growth. Piaget (1952) noted that "knowledge is constructed through a process of accommodation and assimilation, which requires active engagement with the environment" (p. 7). Vygotsky (1978) further asserted that "learning is inherently a social process, influenced by interactions with peers and mentors" (p. 86). These theories underscore the importance of creating opportunities for students to engage in problem-solving and reflective thinking—core elements of prompt engineering.

In prompt engineering, students use AI systems like ChatGPT to test, analyze, and refine prompts. This iterative process aligns with Piaget's constructivist approach to knowledge acquisition and Vygotsky's emphasis on social learning, as students collaborate and receive real-time feedback. Therefore, prompt engineering provides a practical, contemporary application of these cognitive development principles, fostering the growth of critical thinking.

Research on Programming and Interactive Learning Benefits

Research has demonstrated that programming significantly enhances cognitive skills, promoting logical thinking, problem-solving, and creativity. Anderson et al. (2000) assert that "the practice of programming can improve students' problem-solving abilities by engaging them in complex and structured thinking processes" (p. 40). Similarly, Smith and Kosslyn (2007) highlight that "interactive learning environments foster deeper understanding and retention by actively engaging students with the material" (p. 89). These cognitive benefits directly apply to prompt engineering, where students craft and refine AI prompts, engaging deeply with content like programming. In both domains, students must sequence logic, anticipate responses, and evaluate the

outcomes, leading to enhanced problem-solving skills and cognitive engagement.

EDUCATIONAL PSYCHOLOGY

Effective Teaching Methods for Critical Thinking

Active learning strategies have consistently been proven effective in fostering critical thinking. Prince (2004) found that "students engaged in active learning exhibit improved critical thinking abilities and higher retention rates" (p. 223). These methods align seamlessly with a prompt engineering course, where students collaborate in developing and testing prompts, thus creating a dynamic and interactive learning environment. This collaborative approach not only strengthens critical thinking but also promotes peer learning.

Writing effective prompts for LLMs, such as ChatGPT, represents an advanced form of active learning. Students refine their prompts using real-time feedback loops to produce more accurate or valuable responses (Wing, 2006). This process requires deep analysis of the AI's responses and continuously challenges students to improve their input strategies. The iterative nature of this process mirrors real-world problem-solving, enhancing cognitive engagement and fostering adaptable thinking—skills vital in today's fast-evolving professional landscape (Bransford et al., 2000).

Active Learning and AI Inclusion in Curricula

Integrating AI into educational curricula has emerged as a means to enhance student engagement and improve learning outcomes. Barr and Stephenson (2011) argue that "computational thinking is essential for students to thrive in a technology-driven world and should be a fundamental part of education" (p. 48). Students engage with AI-powered tools like ChatGPT through prompt engineering, developing computational thinking skills and learning to solve complex problems through collaborative and iterative processes. This engagement directly reinforces their critical thinking abilities.

INSTRUCTIONAL DESIGN AND TECHNOLOGY

Role of Technology in Education

Technology plays an indispensable role in modern education, offering tools that enhance the learning experience. Mayer (2014) highlights that "multimedia learning environments significantly improve educational outcomes by catering to diverse learning styles" (p. 14). Prompt engineering aligns with this by providing students with a technology-based activity that fosters critical thinking and problem-solving in real-world contexts. Engaging with AI systems through prompt engineering caters to various learning preferences, making it an inclusive educational tool.

Case Studies on AI Integration

Research on AI integration into educational programs offers valuable insights into its effectiveness. Luckin et al. (2016) provide evidence that "AI has the potential to personalize learning and support students in developing critical skills" (p. 23). These findings strongly support the inclusion of prompt engineering in general education as a powerful means to leverage AI to enhance learning. By integrating AI systems like ChatGPT, educational institutions can create learning environments that cater to the diverse needs of students, helping them develop both critical thinking and technology-related skills in a hands-on, engaging manner.

Designing Inclusive and Equitable Programs

The design of educational programs to promote equity and inclusivity is paramount in modern education. Mayer (2014) discusses strategies for "creating learning environments that accommodate diverse student needs and promote equitable access to education" (p. 27). Integrating prompt engineering into general education aligns with these principles, ensuring that all students—regardless of background—have access to engaging and meaningful educational experiences. Prompt engineering can accommodate diverse learning styles and provide equal opportunities for students from various socio-economic backgrounds, contributing to a more inclusive learning environment.

COMPUTER SCIENCE EDUCATION

Early Exposure to Programming and Its Benefits

Early exposure to programming offers significant cognitive benefits, including enhanced problem-solving abilities and improved logical reasoning (Grover & Pea, 2013; Lye & Koh, 2014). Introducing prompt engineering at an early stage can develop these same skills, preparing students for advanced studies and careers in technology. This early engagement fosters computational thinking, which is essential for navigating technology-rich environments.

Moreover, large language models (LLMs) like ChatGPT provide a unique platform where students can develop programming-like skills without encountering the steep learning curve traditionally associated with coding (Resnick et al., 2009). Students engage in cognitive processes akin to programming through prompt engineering, such as logical sequencing, pattern recognition, and hypothesis testing. These skills enhance critical thinking and offer students—particularly those from underprivileged backgrounds—free or low-cost access to tools that were once restricted only to well-resourced institutions. This democratization of technology education empowers a broader range of students to participate in technology-driven fields, fostering equity and inclusion (Warschauer, 2004).

Cognitive Processes in Prompt Engineering and Programming

The cognitive processes involved in programming and prompt engineering are closely linked. Resnick et al. (2009) state that "engaging in programming activities fosters critical thinking and creativity, which are essential skills for

the modern workforce" (p. 60). Prompt engineering involves similar cognitive processes, requiring students to logically sequence their prompts, test hypotheses, and critically evaluate outcomes—all while engaging in iterative learning. These findings underscore the value of incorporating prompt engineering into educational curricula, as it fosters cognitive development and equips students with the critical thinking and creative skills needed for today's workforce.

SOCIOCULTURAL THEORY IN EDUCATION

Impact of Social and Cultural Factors on Learning

Vygotsky's sociocultural theory emphasizes the importance of social interaction and cultural context in learning. Vygotsky (1978) asserts that "learning is inherently a social process, influenced by interactions with peers and mentors" (p. 86). Recognizing these social and cultural factors is vital when designing inclusive and equitable educational programs. Prompt engineering can be tailored to reflect diverse cultural perspectives, enriching the learning experience and ensuring accessibility across different social and cultural contexts.

Strategies for Equity in Education

Educational strategies promoting equity focus on creating inclusive environments where all students have the opportunity to succeed. Banks and Banks (1995) stress the importance of "developing educational practices that address the diverse cultural backgrounds of students" (p. 102). Prompt engineering supports these efforts by offering accessible and engaging ways for students to develop critical thinking skills. This iterative process of experimentation allows students to personalize their learning while engaging with peers from diverse cultural backgrounds.

Promoting Collaboration and Inclusion Through Prompt Engineering

Collaboration is a vital component of effective education. Ladson-Billings (1995) highlights the importance of "promoting collaboration and inclusion in the classroom to enhance learning outcomes" (p. 67). Prompt Crafting, a more creative and hands-on approach to constructing prompts, can incorporate collaborative projects and discussions, where students work together to refine prompts and analyze the outcomes. This collaborative approach fosters an inclusive and supportive learning environment, promoting cross-cultural understanding and helping all students to engage more meaningfully with the material.

DISCUSSION

Prompt Engineering and Critical Thinking

Prompt engineering supports critical thinking by immersing students in iterative processes that require hypothesis formation, testing, and refinement. This hands-on experience reflects Piagetian constructivism, where students actively construct knowledge through engagement with their environment.

PROPOSED BENEFITS OF PROMPT ENGINEERING

Improving Critical Thinking

Literature Synthesis on Programming Enhancing Thinking Skills

Programming has long been recognized for its ability to enhance critical thinking skills. Jonassen (1997) states that "programming requires learners to engage in problem-solving and abstract thinking, which are key components of critical thinking" (p. 65). Similarly, Hmelo-Silver et al. (2007) explain that "problem-based learning, which is central to programming, promotes the development of critical thinking skills by encouraging students to analyze, evaluate, and create solutions" (p. 99). These principles apply directly to prompt engineering, where students construct, test, and refine prompts to elicit desired AI responses, engaging in complex problem-solving and reflective thinking.

Training students to write effective prompts for LLMs like ChatGPT significantly enhances their critical thinking skills. By engaging in the iterative process of prompt design, testing, and refinement, students hone their ability to think strategically, anticipate AI responses, and evaluate the effectiveness of their communication (Jonassen, 1997). Prompt engineering serves as an immediate, feedback-driven mechanism for teaching students how to break down complex problems, reason through potential solutions, and analyze outcomes—all core components of critical thinking (Wing, 2006).

Application to Prompt Engineering

In the context of prompt engineering, students must think critically about how to structure their prompts to achieve specific outcomes from ChatGPT. This process involves hypothesizing, testing, and iterating, which mirrors the scientific method and fosters deep cognitive engagement. As students refine their prompts, they learn to anticipate AI behavior and adjust their strategies accordingly, thus enhancing their critical thinking skills in a practical, hands-on manner.

Promoting Equity and Diversity

Technology's Role in Reducing Educational Disparities

Technology can potentially reduce educational disparities by providing access to high-quality learning resources. Warschauer (2004) argues that "technology can bridge the gap between different socio-economic groups, providing equal opportunities for learning" (p. 34). DiMaggio and Hargittai (2001) highlight that "as internet penetration increases, the digital divide shifts from access to the quality of use, highlighting the need for equitable digital literacy education" (p. 3). Prompt engineering, through the use of ChatGPT, offers a level playing field where all students, regardless of background, can access and benefit from advanced AI-driven educational tools.

Because tools like ChatGPT are widely available and often free to use, they provide an equitable opportunity for students from underprivileged backgrounds to engage in high-level cognitive training (Selwyn, 2011). This availability is critical in bridging the digital divide, as students who might not have access to traditional educational resources can now participate fully in the learning process through these tools. By integrating prompt engineering into the general education curriculum, institutions can ensure that all students have equal access to the benefits of AI-driven education, thereby promoting a more inclusive learning environment that benefits both individuals and society (Warschauer, 2004).

Free Access to ChatGPT Leveling the Playing Field

ChatGPT, as a widely accessible tool, can democratize education by making high-quality learning resources available to everyone. Selwyn (2011) asserts that "the widespread availability of free or low-cost educational technologies can significantly level the playing field for students from diverse backgrounds" (p. 45). By integrating prompt engineering into general education, institutions can ensure that all students have the opportunity to develop critical thinking skills and engage with cutting-edge technology, fostering a more inclusive and equitable learning environment.

3. Cost-Effectiveness

Economic Benefits of Using ChatGPT vs. Traditional Initiatives

Traditional educational initiatives often require substantial investments in resources and infrastructure. Levin and McEwan (2001) emphasize that "cost-effectiveness analysis is essential in evaluating educational programs, ensuring that the benefits justify the expenditures" (p. 12). In contrast, prompt engineering leverages ChatGPT's existing infrastructure, which is both affordable and scalable. This approach significantly reduces the financial burden on educational institutions while maintaining the delivery of a high-quality learning experience.

The use of ChatGPT in educational settings offers considerable economic benefits. Hanushek (2003) argues that "effective educational programs that utilize technology can lead to significant cost savings while maintaining or improving educational outcomes" (p. F65). By adopting ChatGPT for prompt engineering, institutions can minimize costs associated with traditional teaching methods, such as textbooks and physical infrastructure, while maximizing the impact on student learning and engagement.

IMPLICATIONS FOR PRACTICE

Incorporating Prompt Engineering into the General Education Curriculum

Integrating prompt engineering into the general education curriculum equips students with critical thinking and problem-solving skills essential for success in today's technology-driven world. This course can either be offered as a standalone module or embedded within subjects such as computer science, communication, or critical thinking. Barr and Stephenson (2011) assert that "introducing computational thinking into K-12 education requires a concerted effort from the educational community to develop appropriate curricula and training programs" (p. 48). Similarly, in higher education, institutions must carefully plan and develop a curriculum that effectively integrates prompt engineering, aligning course objectives with broader educational goals focused on enhancing critical thinking, equity, and diversity.

Recommended Implementation of Prompt Engineering as a GE Course

Careful planning and strategic alignment with existing curricula are essential to successfully implement the "Integrating Prompt Engineering into General Education" course. Institutions should ensure that the course's objectives promote critical thinking and support the broader goals of fostering equity and diversity in education. As computational thinking becomes more integral to various disciplines, incorporating prompt engineering aligns well with this shift, offering students a hands-on approach to learning that is inclusive and relevant to modern educational needs.

CURRICULUM DEVELOPMENT GUIDELINES

The curriculum for prompt engineering should be designed to engage students through interactive and inclusive learning experiences. Mayer (2014) emphasizes that "effective multimedia learning involves the integration of various instructional methods to cater to diverse learning styles" (p. 14). Achieving this goal requires a balance of theoretical lessons, hands-on activities, and collaborative projects. Additionally, the curriculum should address ethical AI usage and the importance of diversity in technology, ensuring that students not only gain technical skills but also understand the broader societal implications of their work.

Key Components of the Curriculum:

1. **Theoretical Foundations**: Introducing students to the basics of AI, prompt engineering, and computational thinking, with connections to cognitive psychology principles.
2. **Practical Applications**: Hands-on exercises where students develop and refine prompts, critically analyze AI responses, and engage in iterative problem-solving activities.
3. **Collaborative Projects**: Group work that encourages teamwork and the sharing of diverse perspectives, contributing to an inclusive and collaborative learning environment.
4. **Ethics and Diversity**: Modules that focus on the ethical use of AI and the significance of promoting equity and diversity in technology development, ensuring students are prepared to navigate ethical challenges in AI-related fields.

FUTURE RESEARCH RECOMMENDATIONS

Ongoing research is essential for continually refining and improving the effectiveness of prompt engineering as a general education course. Luckin et al. (2016) underscore the importance of "continuous evaluation and research to understand the impact of AI in education and to refine educational practices" (p. 66). Future research should focus on assessing the impact of prompt engineering on students' critical thinking, engagement, and understanding of equity and diversity. Additionally, long-term studies can provide valuable insights into how integrating prompt engineering into general education impacts students' academic and professional trajectories.

Areas for Future Research:

1. **Impact Assessment**: Evaluating the effectiveness of prompt engineering in enhancing students' critical thinking skills and promoting equity and diversity within educational settings.
2. **Curriculum Refinement**: Continuously improving course content based on feedback from students and educators to ensure the material remains engaging and relevant.
3. **Long-Term Outcomes**: Investigating prompt engineering education's long-term academic and professional benefits, including its influence on students' success in technology-driven fields.
4. **Technological Advancements**: Exploring how emerging AI technologies can be integrated into the curriculum to ensure it remains current and reflective of the latest advancements in the field.

CONCLUSION

Summary of Key Theoretical Arguments and Implications

This paper has examined the integration of prompt engineering into general education, highlighting its potential to enhance critical thinking while promoting equity and diversity. A robust theoretical foundation has been established by drawing from cognitive psychology, educational psychology, instructional design, and computer science education. Piaget (1952) proposed that "knowledge is constructed through a process of accommodation and assimilation," emphasizing active engagement in the learning process (p. 7). Prompt engineering aligns with this principle by engaging students in iterative, reflective practices that mirror the cognitive processes found in programming, thereby fostering critical thinking.

Reiteration of the Importance of Critical Thinking, Equity, and Diversity

The development of critical thinking is vital in contemporary education. Jonassen (1997) stated that "programming requires learners to engage in problem-solving and abstract thinking, which are key components of critical thinking" (p. 65). Incorporating prompt engineering into the curriculum equips students with the tools necessary to develop these skills. In addition to enhancing critical thinking, the course promotes equity and diversity by ensuring that students from all backgrounds have access to high-quality learning opportunities. Warschauer (2004) pointed out that "technology can bridge the gap between different socio-economic groups, providing equal opportunities for learning" (p. 34). Prompt engineering directly contributes to this goal, leveling the educational playing field for all students.

Final Argument for Adopting Prompt Engineering as a Required Course

In conclusion, adopting prompt engineering as a required General Education course offers several key benefits. It provides students with a practical, hands-on learning experience that fosters critical thinking, promotes inclusivity, and takes advantage of widely available, low-cost tools like ChatGPT. Selwyn (2011) observed that "the widespread availability of free or low-cost educational technologies can significantly level the playing field for students from diverse backgrounds" (p. 45). By incorporating prompt engineering into general education, institutions can ensure that all students, regardless of their socio-economic background, are well-prepared to thrive in a technologically advanced world.

Training students to craft prompts for LLMs like ChatGPT is an effective approach to enhancing critical thinking and fostering educational equity (Wing, 2006). This method engages students in higher-order thinking while providing a platform accessible to all learners. By incorporating prompt engineering into general education, institutions contribute to creating an equitable and inclusive educational environment that prepares students for success in a technology-driven future (DiMaggio &Hargittai, 2001). The widespread availability of AI tools democratizes education, allowing underprivileged students to compete on equal footing with their peers, ultimately benefiting society as a whole (Warschauer, 2004).

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